P/G 110329-USA-AT

VERIFICATION OF TRANSLATION

I, the below-named person, hereby certify that I am familiar with both the Japanese and the English language, that I have reviewed the attached English translation of a U.S. Patent Application, filed April 2, 2004, and that the English translation is an accurate translation of the corresponding Japanese language paper, which:

- ☐ is attached; and/or
- ☒ was filed on the above date and identified as Attorney Docket No. 065905-0318 (further identified as Serial No._____).

I further declare that all statements made in this declaration of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of legal decisions of any nature based on them.

April 21, 2004
Date

Toshio Kawahara
Name : Toshio Kawahara

PIG110329-USA-AT

TITLE OF THE INVENTION

PAPER SUPPLY DEVICE AND IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a paper supply device to convey sheets of paper in the paper supplying direction by separating one by one certainly and an image forming apparatus.

2. Description of the Related Art

In image forming apparatus such as printers, copying machines or facsimiles, a paper separation mechanism is incorporated to supply sheets of paper taken out of paper supply cassettes or paper supply tray by separating one by one in a direction of image forming apparatus. As one of sheet separation mechanisms, there is an image forming apparatus that has a paper supply roller to rotates sheets of paper in the paper supply direction and a separation roller to rotates in the reverse direction through a torque limiter to separate sheets of paper one by one pass between a paper supply roller and a separation roller. A device to compress a separation roller to a stationary paper supply roller with a spring or other press fitting means is disclosed in Japanese Patent Publication No. 11-199075.

However, in an apparatus which press fits a paper supply roller and a separation roller by a press fitting means such as an above-mentioned spring, press fitting forces of the paper supply roller and the separation roller change according to variance or

change of compression force of a press fitting means for fatigue or decrease in the outer diameters of the rollers and change in mounting conditions of a press fitting means resulting from the wear of the outer circumference of the paper supply roller or the separation roller. Therefore, the press fitting force between the paper supply roller and the separation roller goes out from the sheet paper separatable range and paper clogging for impossibility of paper supplying or overlapped sheet feeding for impossibility of separation can be generated. Further, when it is tried to prevent the change in mutual pressure fitting force of the paper supply roller and the separation roller in a construction using such press fitting means as the above-mentioned spring, etc., various restrictions may be generated in specifications of press fitting means and rollers and cost increase may result.

Therefore, an image forming apparatus using a paper supply device capable of surely separating and conveying sheets of paper for an extended period by reducing change in mutual pressure fitting force of a paper supply roller and a separation roller for variance in press fitting force or secular change at a low price is demanded.

SUMMARY OF THE INVENTION

An object of this invention is to separate sheets of paper and convey surely for an extended period by holding a press fitting force between a paper supply roller and a separation roller within a sheets of paper separable range without impeding the achievement

of cost reduction.

According to the embodiments of this invention, a paper supply device has a paper supply roller to rotate in the paper supply direction, a separation roller to hold a paper jointly with the paper supply roller and constantly maintain a driving force to drive paper in the reverse direction of the paper supply roller, and a weight to press fit the paper supply roller to the separation roller by applying a required load to the paper supply roller.

Further, according to the embodiments of this invention, a paper supply device has a paper supply roller to rotate in the paper supply direction, a separation roller to hold a paper jointly with the paper supply roller and always maintain a driving force in the direction reverse to the paper supplying direction by the paper supply roller, a weight to apply a required load to the paper supply roller and press fit the paper supply roller to the separation roller, and an elastic member to press fit between the paper supply roller and the separation roller by applying a compression force to either the paper supply roller or the separation roller separation roller.

Further, according to the embodiments of this invention, an image forming apparatus has an image carrier, an image forming unit to form a toner image on the image carrier, a transfer unit to transfer the toner image on a sheet paper, a paper supply roller to rotate to feed sheet paper in the direction of the transfer unit, a separation roller to hold the sheet paper jointly with the paper supply roller and always retain a driving force in the direction reverse to the paper supply direction by the paper supply roller, and

a weight to apply a required load to the paper supply roller and press fit the paper supply roller to the separation roller by the load.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic construction diagram showing an image forming apparatus in a first embodiment of this invention;

FIG. 2 is a schematic perspective view showing a separation/conveying device in the first embodiment of this invention;

FIG. 3 is a side view showing the separation/conveying device in the first embodiment of this invention;

FIG. 4 is a schematic explanatory diagram showing the press fitting of a paper supply roller and a separation roller in the first embodiment of this invention;

FIG. 5 is a graph showing press fit force setting conditions of the paper supply roller in the first embodiment of this invention;

FIG. 6 is a schematic perspective view showing a separation/conveying device in a second embodiment of this invention; and

FIG. 7 is a graph showing a range of variance of the press fit force of a paper supply roller at the initial stage in the second embodiment of this invention.

DETAILED DESCRIPTION OF THE INVENTION

A first embodiment of this invention will be explained below in detail referring to the attached drawings. FIG. 1 is a construction

diagram showing the entire construction of a monochromatic image forming apparatus 10 to which supplies sheets of paper using a paper supply device in the first embodiment of this invention. Image forming apparatus 10 is equipped with a cassette mechanism 3 comprising paper supply cassettes 3a, 3b, 3c and 3d to feed sheets of paper P that are recording media in the direction of image forming unit 2. Further, image forming apparatus 10 is equipped with a manual paper supplying mechanism to take out sheets of paper P with a manual pick-up roller 4b from a paper supply tray 4a and separate and convey sheets of paper P with a manual separation roller 4c, and a reverse conveying path 5 to reverse and convey sheets of paper P when it is desired to form images on the both side of sheets of paper. On the top of image forming apparatus 10, a scanner device 6 is provided to read document images.

Scanner 6 has a document glass 61 on which documents are placed, a platen 62 to cover document glass 61, an optical system unit 63 to apply light to documents and focus reflecting light from documents, and a CCD scanner unit 64 to read light from optical system unit 63.

Developing image forming unit 2 has a charger 12 to uniformly charge a photosensitive drum 11 sequentially according to the rotating direction of an arrow q of photosensitive drum 11, an exposing unit 13a of a laser optical device to form a latent image on charged photosensitive drum 11 based on image data from scanner 6, a developing unit 14, a transfer charger 16 that is a transfer unit, a separation charger 17, a cleaner unit 18 and a charge eliminating

LED 19 around photosensitive drum 11 that is an image carrier.

At the downstream side in the conveying direction of sheets of paper P of developing image forming unit 2, a fixing device 22 is provided to convey sheets of paper P by holding with a heat roller 20 having a built-in heater lamp and fix a toner image by heating and pressing it. At the downstream of fixing device 22, discharge rollers 24 are provided to discharge sheets of paper P on a discharge tray 23 after fixed.

A conveying path 7 having pick-up rollers 30a, 30b, 30c, 30d to take out sheets of paper P, a separation/ conveying device 31a that is a paper supplying device having a paper supply roller pair 37, and first through third conveying rollers 32a, 32b, 32c and aligning rollers 33 are provided between paper supply cassettes 3a, 3b, 3c, 3d and developed image forming unit 2.

Next, separation/conveying devices 31a to 31d will be described in detail. Further, separation/conveying devices 31a to 31d are in the same construction and therefore, taking one them as an example, they will be explained. For example, separation/conveying device 31a has a paper supply roller 37, a sheets of paper P separation roller 38 opposing to paper supply roller 37, and metal weight 40 attached to a paper supply shaft 37a as shown in FIG. 2 and FIG. 3.

Separation roller 38 is made of synthetic rubber, etc. having a high coefficient of friction and attached to separation shaft 38 via a torque limiter 42. Separation shaft 38a is supported at both ends by separation roller bearing unit 44 fixed to a rib 43 provided in conveying path 7. Separation roller 38 is blocked to rotate in the

direction, that is the paper supplying direction, of transfer charger 16 until a torque applied to separation roller 38 by opposite paper supply roller 37 exceeds a reversing torque. When the torque applied to separation roller 38 by paper supply roller 37 exceeds the reversing torque, separation roller 38 is switched to follow the drive of paper supply roller 37 or sheets of paper P conveyed and driven in the arrow direction r, that is the paper supply direction.

Paper supply roller 37 is made of synthetic rubber, etc. having a high coefficient of friction and is driven and rotated by a driving motor 47 via paper supply shaft 37a in the arrow direction s; that is, the paper supply direction, and conveys sheets of paper P in the direction of photosensitive drum 11. The drive input side of paper supply shaft 37a that is linked to driving motor 47 via a joint 50 is supported by a stationary supporting point side bearing unit 48. Paper supply shaft 37a is able to oscillate in the arrow direction t centering around supporting point side bearing unit 48.

As being capable of oscillating in the arrow direction t, paper supply shaft 37a is directed to slide to a slit 51a of a pressurizing side bearing unit 51 near paper supply roller 37. Further, as paper supply shaft 37a is oscillated in the arrow direction t, a paper supply gear 46 has a certain play with driving motor 47.

Weight 40 is attached to the oscillation side of paper supply shaft 37a and applies a load to paper supply roller 37. Paper supply roller 37 is press contacted to separation roller 38 by it's own weight and a load of weight 40 toward a center 38b of separation roller 38 as shown by an arrow u in FIG. 4.

Setting conditions of the press fitting force of paper supply roller 37 to separation roller 38 and a reversing torque of torque limiter 42 in the feeding of sheets of paper P by separation/conveying device 31a in this embodiment are restricted as shown in FIG. 5. A hatched trapezoidal area (γ) of press fitting force 350 to 450 (gf) enclosed by a non-feed generating area (α) and overlapped sheets feed generating area (β) is an area for the good separation/conveying and an area for setting a press fitting force of paper supply roller 37 and a reversing torque of torque limiter 42. Further, this trapezoidal area (γ) is virtually controlled by type of using sheets of paper, and coefficients of friction of paper supply roller 37 and separation roller 38.

Here, the less the reversing torque of torque limiter 42 is made small, the less the press fitting force setting range of paper supply roller 37 is narrowed. However, the press fitting force of paper supply roller 37 by a load of weight 40 can be maintained at a constant level irrespective of secular change or change from wear of paper supply roller 37 and separation roller 38. Accordingly, when paper supply roller 37 is press contacted by a load of weight 40, it becomes possible to make a reversing torque of torque limiter 42 small.

For example, when a reversing torque range of torque limiter 42 is set at 380 to 450 (gf.cm) in FIG. 5, a press fitting force of paper supply roller 37 is restricted to 360 to 440 (gf) and an area for good separation/conveying of sheets of paper P becomes an area (δ) enclosed by the one-dot chain line shown in FIG. 5. Accordingly, it

is advisable to set a weight of weight 40 so that a press fitting force of paper supply roller 37 to separation roller 38 comes in the (δ) area. For example, when an own weight of paper supply shaft 37a is 40(g) and that of paper supply roller 37 is 20(g), it is sufficient to set weight 40 at 400 to 500(g).

Next, actions of the image forming apparatus will be described. When the image forming process starts, a document is read in scanner unit 6. In developing image forming unit 2, and after uniformly charged by charging device 12 according to its rotation in the arrow direction q, photosensitive drum 11 is applied with laser beam corresponding to a document image and an electrostatic latent image is formed thereon. Then, the electrostatic latent image is developed in developing unit 14 and a toner image is formed on photosensitive drum 11.

On the other hand, in cassette mechanism 3 or manual paper supplying mechanism 4, specified sheets of paper P is taken out with pick-up roller 30a to 30d or manual pick-up roller 4b. Sheets of paper P taken out from paper supply tray 4a is separated and conveyed in the direction of alignment roller 33 by manual separation roller 4c. Sheets of paper P taken out from paper supply cassettes 3a to 3d are separated to one by one while passing through separation/conveying devices 31a to 31d with paper supply roller 37 applied with a fixed load by weight 40 kept press contacted and conveyed in the direction of aligning roller 33.

After the leading edges are aligned by aligning roller 33, sheets of paper P are conveyed to the position of transfer charger 16 in

synchronous with a toner image on photosensitive drum 11 and then, separated from photosensitive drum 11 by separation charger 17 after a toner image is transferred. After sheets of paper P are separated, photosensitive drum 11 is cleaned by removing residual toner with cleaner unit 18, residual charge is eliminated with charge elimination LED 19 and stands to next image forming process. Sheets of paper P with an unfixed toner image formed thereon and separated from photosensitive drum 11 are inserted between a heat roller 20 and a press roller 21 of an fixing device 22 and a toner image is heated, pressurized and fixed.

While sheets of paper P taken out from cassette mechanism 3 or manual paper supply mechanism 4 are separated and conveyed, paper supply roller 37 and separation roller 38 are worn away. However, even when paper supply roller 37 and separation roller 38 are worn, a load applied to paper supply roller 37 by weight 40 is kept at a constant level. Therefore, a press fitting force of paper supply roller 37 to separation roller 38 remains at 360 to 440 (gf) at the initial stage shown in an area δ enclosed with the one-dot chain line in FIG. 5 irrespective of wear of paper supply roller 37 and separation roller 38, and sheets of paper P are separated and conveyed certainly.

According to this first embodiment, paper supply roller 37 is press contacted to separation roller 38 using weight 40 of which load to paper supply roller 37 does not change and a press fitting force between paper supply roller 37 and separation roller 38 remains unchanged at the same level as that at the initial stage irrespective

of secular change and wear of paper supply roller 37 and separation roller 38. Accordingly, separation/conveying devices 31a to 31d are able to separate and convey sheets of paper P certainly for an extended period irrespective of wear of paper supply roller 37 and separation roller 38. Further, because a reversing torque of torque limiter 42 can be made small, it becomes possible to use a small, light and low price torque limiter 42.

Next, a second embodiment of this invention will be explained. In this second embodiment, the paper supply roller is loaded differently from the load in the first embodiment. Therefore, in the second embodiment, the same component elements as those in the first embodiment are assigned with the same reference numerals and detail explanations thereof will be omitted here. In this embodiment, a weight 53 is attached to the oscillation side of paper supply shaft 37a as shown in FIG. 6. Further, weight 53 is pressed in the direction of separation roller 38 by an auxiliary pressing mechanism 54 that is an elastic member having an auxiliary compressing lever 54a and an auxiliary compressing spring 54b.

Accordingly, paper supply roller 37 is compressed against separation roller 38 by own weight and a load of weight 53 and further, by the compressing force of auxiliary compressing mechanism 54. When it is tried to generate a press fitting force of paper supply roller 37 to separation roller 38 only by it's own weight of paper supply roller 37 and a load of weight 53, weight 53 becomes large in size and cost increase will result. So, in this embodiment, a margin of change in press fitting force of paper supply roller 37 to

separation roller 38 is increased while the apparatus is made small in size and light in weight to balance both merits.

For example, in a conventional apparatus in which the press fitting force of paper supply roller 37 to separation roller 38 is generated only by a compression force of a compression spring and it is necessary to set conditions for press fitting force with a compression spring by fully considering variance in compression force of a compression spring for its deterioration or wear of paper supply roller 37 and separation roller 38.

Therefore, in the conventional apparatus described above, it is necessary to secure the press fitting force by a compression spring in the range of variance 360 to 440 (gf) largely from the initial stage as shown in the area (η) enclosed by the dotted line in FIG. 7. Therefore, in the above-mentioned conventional apparatus, a difference between the area (η) and the trapezoidal area (γ) in which sheets of paper can be separated and conveyed satisfactorily is small and therefore, there is almost no margin in setting conditions for a compression spring and a high accuracy is demanded in the manufacture or mounting of a compression spring.

On the contrary, in this embodiment, for example, when 1/2 of the press fitting force of paper supply roller 37 to separation roller 38 is generated by an own weight of paper supply roller 37 and a load of weight 53 and the remaining 1/2 is generated by the compression force of auxiliary compression mechanism 54, the small sized and light weight apparatus can be obtained as a result of decrease in the weight of weight 53 and further, variance in press

fitting force of paper supply roller 37 caused by variance in compression force of auxiliary compression spring 54b can be reduced to 1/2.

As a result, when a range of variance of press fitting force of paper supply roller 37 to separation roller 38 by auxiliary compression spring 54b in this embodiment was verified, it was found that the range of variance in press fitting force of paper supply roller 37 by auxiliary compression spring 54b at the initial stage could be reduced to 380 to 420 (gf) as shown in the hatched area (θ) in FIG. 7. Accordingly, in this embodiment, a difference between the area (θ) and the trapezoidal area (γ) that is an area for a good separation and conveyance is large and a large margin can be secured when setting conditions for auxiliary compression spring 54b, and the cost reduction can be achieved for the reduction of manufacturing or mounting accuracy of auxiliary compression spring 54b. Further, the cost reduction resulting from the mitigation of spring constant of auxiliary compression spring 54b also can be obtained.

Further, in the comparison of a conventional apparatus with this embodiment, when a compression spring constant of a conventional apparatus is assumed as Ko and a spring constant of auxiliary compression spring 54b in this embodiment is assumed as Ki, $Ko > Ki$. When a variation in the outer diameter of paper supply roller 37 and separation roller 38 due to wear at the time when paper supply roller 37 and separation roller 38 reached the service life is assumed as ΔR, the variance reduction effect of press

fitting force of paper supply roller 37 in this embodiment against a conventional apparatus is expressed by $\Delta R \cdot (Ko\text{-}Ki)$. That is, the variance of press fitting force of paper supply roller 37 in this embodiment is surely reduced more than conventional apparatus.

In this embodiment, sheets of paper P taken out from cassette mechanism 3 by pick-up rollers 30a to 30d are separated to each sheet when passing through separation/ conveying devices 31a to 31d wherein paper supply roller 37 is press contacted to separation roller 38, conveyed in the direction of aligning roller 33 and a toner image is formed.

Further, in separation/conveying devices 31a to 31d, the side edge of weight 53 of paper supply shaft 37a is free and therefore, paper supply roller 37 may damp when sheets of paper P are separated and conveyed. However, in this embodiment, paper supply roller 37 is pressed down in the direction of separation roller 38 by auxiliary compression mechanism 54 via weight 53 and therefore, paper supply roller 37 separates and conveys sheets of paper P satisfactorily without causing the damping.

Thus, while sheets of paper P taken out from cassette mechanism 3 are separated and conveyed, paper supply roller 37 and separation roller 38 are worn in separation/convey devices 31a to 31d. The compression force of auxiliary compression spring 54b changes for wear of paper supply roller 37 and separation roller 38 and furthermore, the press fitting force of paper supply roller 347 changes.

However, the effect of change in the compression force of

auxiliary compression spring 54b to the press fitting force of paper supply roller 37 is reduced to 1/2 and even when paper supply roller 37 and separation roller 38 are worn, until the press fitting force of paper supply roller 37 exceeds the trapezoidal area (γ) that is an area for a good separation and conveying, separation/conveying devices 31a to 31d separate and convey sheets of paper P surely and the long life is obtained.

According to this second embodiment, the press fitting force of paper supply roller 37 and separation roller 38 is generated by both of a load of weight 53 and the compression force of auxiliary compression mechanism 54. Therefore, weight 53 can be made small in size and light in weight and cost reduction is achieved by reduction of a spring constant of auxiliary compression spring 54b. Furthermore, the range of variance of press fitting force of paper supply roller 37b by auxiliary compression spring 54b at the initial stage can be lowered and as a result, the cost reduction in manufacturing or mounting of auxiliary compression spring 54b can be achieved.

Further, the variance of press fitting force of paper supply roller 37 by the change in compression force of auxiliary compression mechanism 54 is suppressed to 1/2 and the long life of separation/conveying devices 31a to 31d can be achieved irrespective of secular change or wear of paper supply roller 37 and separation roller 38. In addition, the damping of paper supply roller 37 can be prevented by auxiliary compression mechanism 54 and it becomes possible to separate and convey sheets of paper P satisfactorily.

This invention is not restricted to the above-mentioned embodiments but can be modified variously within the scope of this invention. For example, size and material of the paper supply roller and the separation roller are optional and the reversing force of the torque limiter is also not restricted. Further, a size of a weight is also optional. In addition, the paper supply roller itself may be made heavier so as to generate a press fitting force between the paper supply roller and the separation roller and the paper supply roller itself may be used as a weight.

Further, when the dumping may be caused on the paper supply roller in the first embodiment, the weight and the paper supply shaft can be made light using a sponge, a hydraulic damper, etc. Further, in the second embodiment, a rate of press fitting force that is generated in the paper supply roller by the weight and the auxiliary compression mechanism is not restricted. Further, the auxiliary compression mechanism may be provided at the separation roller side and a press fitting force required between the paper supply roller and the separation roller may be generated by a press fitting force from the paper supply roller side for own weight of paper supply roller 37 and a load of weight 53 and a press fitting force by the compression force of the auxiliary compression mechanism at the separation roller side.

As described above in detail, according to this invention, a press fitting force between the paper supply roller and the separation roller generated by a load of the weight remains unchanged from the initial stage when the paper supply roller and

the separation roller are press fitted using a weight to apply a fixed load to the paper supply roller, and it becomes possible to separate and convey sheets of paper by the paper supply roller and the separation roller certainly for an extended period irrespective of secular change or wear of the paper supply roller and the separation roller.

Further, when a press fitting force is generated between the paper supply roller and the separation roller using an elastic member in addition to a load of the weight, the press fitting force of the paper supply roller is affected by the compression force of the elastic member or wear of the paper supply roller and the separation roller but the press fitting force of the paper supply roller by a load of the weight is not changed and the variance of press fitting force of the paper supply roller can be reduced as a whole and the life of the separation and conveying function of sheets of paper by the paper supply roller and the separation roller can be extended.